LA-UR-21-21997
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Title: Physics-Based Modeling of Space Weather During Large and Extreme Geomagnetic Storms

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Intended for: Report

Issued: 2021-02-28

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Physics-Based Modeling of Space Weather During Large and Extreme Geomagnetic Storms

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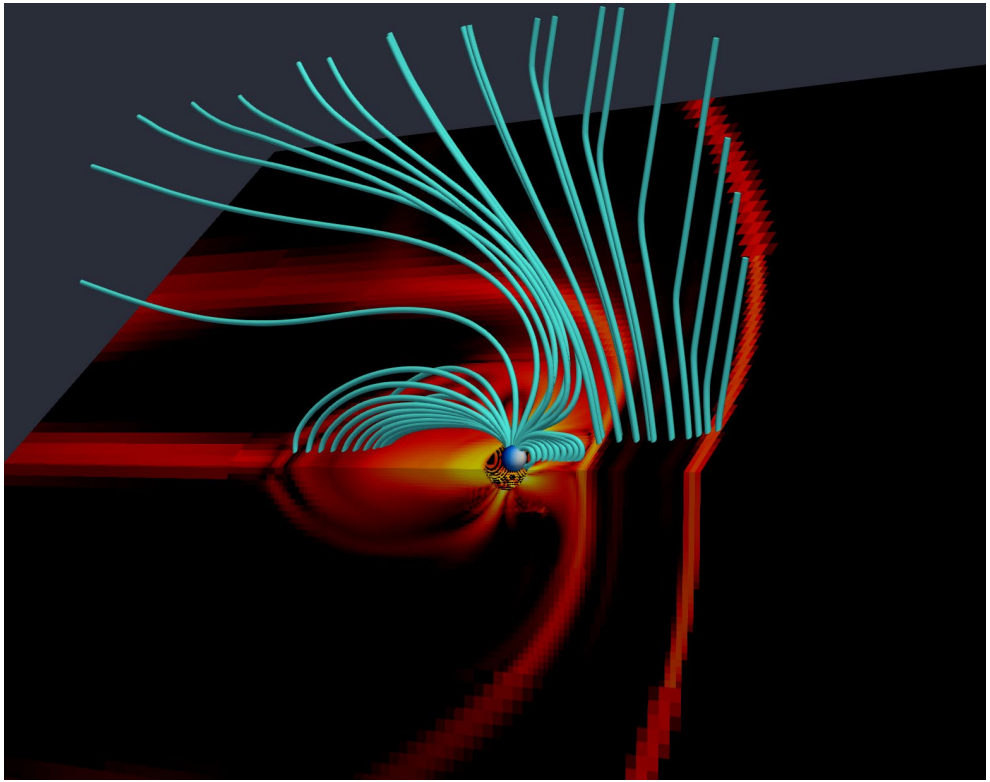
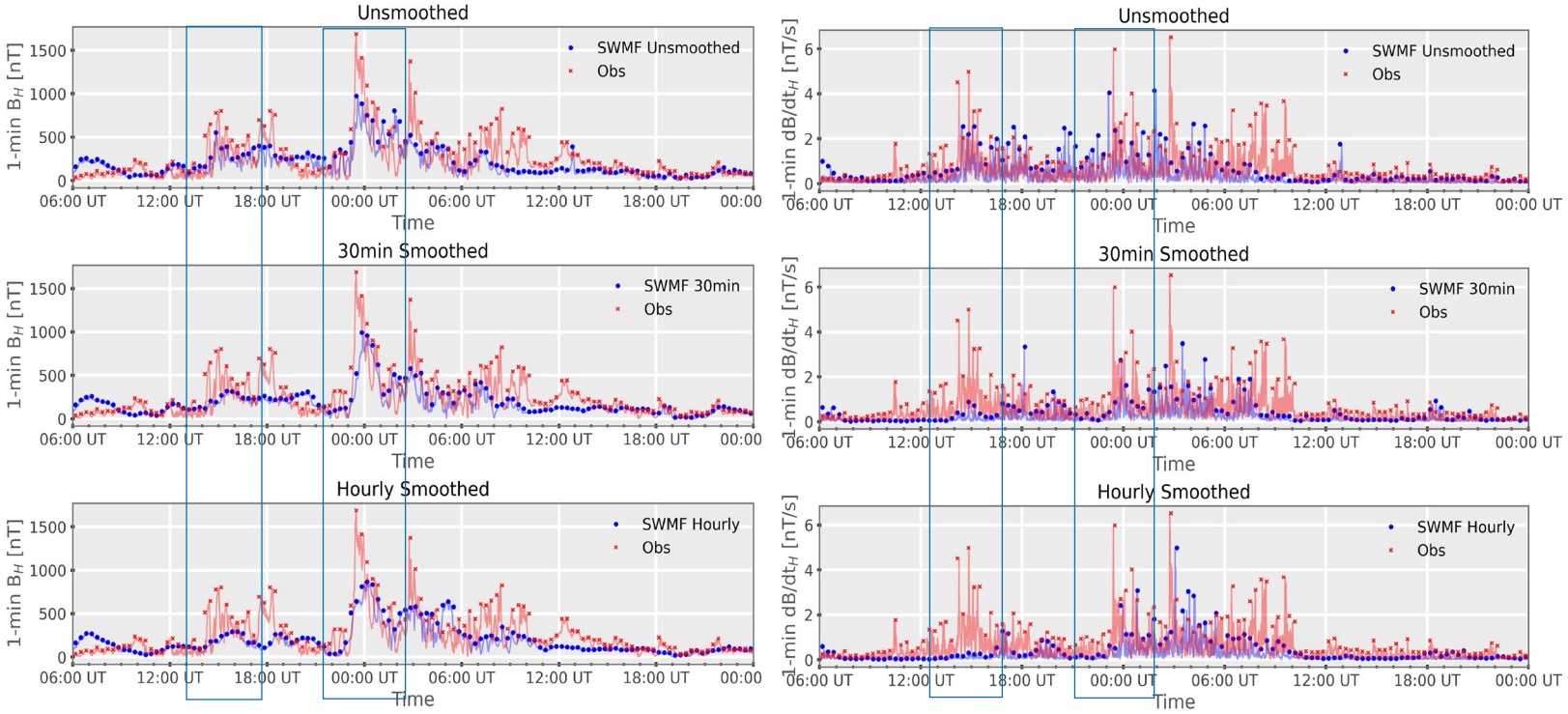
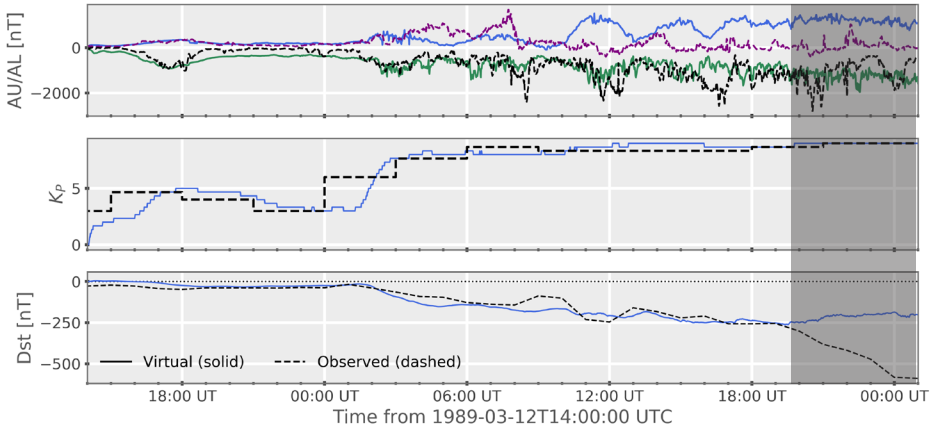


Results from the Space Weather Modeling Framework. The color shows the current density. The cutaway volume shows the structure of the magnetosphere and bow shock. The increase in resolution towards the Earth can be seen in the bow shock, illustrating the multi-resolution grid. The configuration of the magnetic field, which determines particle access, is shown by the blue field lines. Temporal variations in the field and currents drives geoelectric fields on Earth's surface which presents a hazard to power transmission infrastructure.



Results from a study of the impact of small-scale structure on Space Weather Modeling Framework predictions. Each panel shows the predicted magnetic perturbation (left column) and the rate-of-change of the magnetic field (right column) at Iqalut station. The top row includes all measured structure, while the rows below use successively filtered upstream boundary conditions. Reduced measurement cadence, or smooth "idealized" simulation drivers will lead to underestimates of the hazard to power transmission operators.



Results from a reconstruction of the geomagnetic storm that led to the failure of the HydroQuebec power grid in March 1989. The early part of the storm where the grid failure occurred is well reproduced in global activity measures (left). The panel below shows a map of predicted magnetic field rate-of-change near the time of infrastructure impact. The magnitude of response is similar to observations, but occurs at higher latitude than was seen in the actual event.